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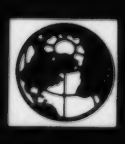

TITLE: RELATIONSHIP BETWEEN PROCESS PARAMETERS AND WIRE FEED SPEED FOR ARC WELDING PROCESSES

Final Report

by: S. Santyr
G. Proux

Work on the project was conducted under the auspices of the Canada Centre for Mineral and Energy Technology, Energy, Mines and Resources Canada.

DSS File No. 06SQ.23440-5-9049

DSS Contract Series No. OSQ85-00023

CANMET Project No.

CANMET Scientific Authority: Dr. R.S. Chandel

Date: September 1986

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MICROMEDIA

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Executive Summary

Bead on plate welds were made using 604 combinations of current, voltage, electrode stick out, wire diameter, polarity and flux or gas shielding. Subsequent to welding, bead shape measurements were taken.

This particular work will be used to study the effects of welding parameters for both the SAW and GMAW processes on the WFS, penetration and net heat input.

Sommaire Exécutif

Six cents quatre cordons de soudure sur plaques ont été fait avec différentes combinaisons de courrant, voltage, diamètre de fils, l'extension électrique, polarité et flux ou gaz de protection. Une fois soudé, le profil du cordon a été mesuré.

Ces travaux vont donc êtres utilisé pour l'étude de l'effet de paramêtres de soudure pour les procédés a l'arc submergé et à l'arc sous protection gazeuse sur la vitesse de l'avance du fis la pénétration et l'apport calorifique.

INDEX

	Page No
1.0 Introduction	3
2.0 Experimental Procedure	
2.1 Materials	
2.1.1 Steel	3
2.1.2 Consumables	4
2.2 Weld Procedure	5
2.3 Bead Shape Measurements	6
3.0 Summary	7

Figure 1 Bead Measurements

Table 1 Submerged Arc Welding with DC Current
Table 2 Submerged Arc Welding with AC Current
Table 3 Gas Metal Arc Welding with DC Current
Table 4 Bead Shape Measurements

1.0 INTRODUCTION

A total of 604 bead on plate welds were produced at the AMCA International Research and Technology Centre. These were made using a systematic series of parameters covering specified current and voltage ranges. Electrode stickout, wire diameter, voltage type (i.e. AC square wave, DCRP, DCSP) and flux or gas shielding were also varied systematically.

Ultimately these welds will be used to study the relationship between welding parameters, wire feed speed and weld bead shape for the submerged arc and gas metal arc welding processes, the results of which will help in defining welding procedures for fully automatic processes.

2.0 EXPERIMENTAL PROCEDURE

2.1 Materials

2.1.1 Steel

ASTM A36 steel was used as the baseplate for all of the welds.

Each weld was made on an individual plate measuring 610 mm x 150 mm x 19 mm. This was performed in order to provide similar cooling conditions for every weld.

2.1.2 Consumables

The program was carried out in two phases. In the first phase, submerged arc welding parameters and consumables were varied and in phase two, gas metal arc welding parameters and gases were varied.

In phase one, Lincoln L60 wire was used with both Linde 124 flux (2.4, 3.2 and 4.0 mm diameter) and Oerlikon OP121TT flux (3.2 mm diameter only).

These combinations were used with both DC straight and DC reverse polarity. The following combinations were then used with AC current with a square wave output: L60 (4.0 mm)/Linde 124, L60 (3.2 mm)/Linde 124, L60 (3.2 mm)/Oerlikan OP121TT.

In phase two, Linde 86 wire was used with C-25 gas (0.9, 1.2 and 1.6 mm diameter), M-2 gas (0.9, 1.2 and 1.6 mm diameter) and C-15 gas (0.9 mm diameter only).

These combinations were used with both DC straight and DC reverse polarity.

2.2 Weld Procedure

In phase 1 of the program, process parameters were varied as shown in Tables 1 and 2. Currents and voltages were preset and travel speed was adjusted to give a heat input of 3 kJ/mm.

Two levels of electrode stickout were used.

Wire feed speeds were noted for each weld and recorded in Tables 1 and 2.

In phase 2 of the program, the same testing scheme was adopted for the first wire diameter (0.9 mm). That is, a set heat input of 1 kJ/mm, two levels of electrical stickout, three shielding gases, two polarities, two voltages, three currents and a travel speed adjusted to obtain the required heat input.

Upon completion of this first set of welds, the experimental approach was changed to one in which there was a fixed grid of variables with only one parameter changed per test. The new scheme allowed a much less convoluted analysis of the effects of individual parameters on weld bead characteristics. The heat input was no longer held constant and the grid of variables included the following; two levels of electrical stick-out, two shielding gases, two polarities, two voltages, three current levels and two travel speeds. The selected parameters for phase 2 are shown in Table 3.

Some of the combinations of parameters shown in Table 3 could not be achieved. These are indicated as one of the following three conditions:

a) a "blank" under wire feed speed means that the conditions were unobtainable and no weld was made.

b) a change in matrix indicates that the maximum amperage achievable with the equipment was used.

c) some specimens had erratic bead shapes due to non-optimum operating conditions such that no representative section could be obtained.

2.3 Bead Shape Measurements

Cross sections from each weld were labelled, surface ground and etched in 10% aqueous nitric acid.

Bead shapes were traced onto acetate, at a magnification of 5x, using a Reichart microscope.

The acetate tracings were then measured on a Zeiss Videoplan Image Analysis system. The required dimensions for measurement are shown in Figure 1. These include the deposited area, bead height, bead width, fused area and bead penetration. For the phase 2 measurements, the length of the fused boundary was also included.

The bead on plate dimensions are listed in Table 4. Where samples were missing or duplicated, there is a "blank" next to the identification number. Where no weld was made or no section was cut, due to erratic conditions, this is indicated next to the identification number.

3.0 SUMMARY

1. Bead on plate welds were made for both the submerged arc and gas metal arc welding processes.

2. Weld parameters were varied systematically to obtain a broad data base.

3. Bead shape measurements were made so that weld parameters could be related to bead shape and size.

TABLE 1: RELATIONSHIP BETWEEN PROCESS PARAMETERS AND WIRE FEED SPEED FOR ARC WELDING PROCESS

Submerged Arc Welding with DC Current - Heat Input 3 kJ/mm

MILLER DC 1500 CONSTANT VOLTAGE

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	FLUX TYPE	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
1	Lincoln L60	3/32	Linde 124	DC-	32	300	7.6	92	1
2	"	"	"	"	35	300	8.3	92	1
3	"	"	"	"	38	300	9.0	92	1
4	"	"	"	"	32	400	10.1	133	1
5	"	"	"	"	35	400	11.0	133	1
6	"	"	"	"	38	400	12.0	133	1
7	"	"	"	"	32	475	12.0	165	1
8	"	"	"	"	35	475	13.1	165	1
9	"	"	"	"	38	475	14.2	165	1
10	"	"	"	"	32	550	13.9	200	1
11	"	"	"	"	35	550	15.2	200	1
12	"	"	"	"	38	550	16.5	200	1
13	"	"	"	"	32	300	7.6	121	3
14	"	"	"	"	35	300	8.3	121	3
15	"	"	"	"	38	300	9.0	121	3
16	"	"	"	"	32	400	10.1	184	3
17	"	"	"	"	35	400	11.0	184	3
18	"	"	"	"	38	400	12.0	184	3
19	"	"	"	"	32	475	12.0	244	3
20	"	"	"	"	35	475	13.1	244	3
21	"	"	"	"	38	475	14.2	244	3
22	"	"	"	"	32	550	13.9	322	3
23	"	"	"	"	35	550	15.2	322	3
24	"	"	"	"	38	550	16.5	322	3

.../continued

TABLE 1...continued

Submerged Arc Welding with DC Current - Heat Input 3 kJ/mm

MILLER DC 1500 CONSTANT VOLTAGE

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	FLUX TYPE	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
25	Lincoln L60	3/32	Linde 124	DC+	32	300	7.6	70	1
26	"	"	"	"	35	300	8.3	70	1
27	"	"	"	"	38	300	9.0	70	1
28	"	"	"	"	32	400	10.1	93	1
29	"	"	"	"	35	400	11.0	93	1
30	"	"	"	"	38	400	12.0	93	1
31	"	"	"	"	32	475	12.0	117	1
32	"	"	"	"	35	475	13.1	117	1
33	"	"	"	"	38	475	14.2	117	1
34	"	"	"	"	32	550	13.9	147	1
35	"	"	"	"	35	550	15.2	147	1
36	"	"	"	"	38	550	16.5	147	1
37	"	"	"	"	32	300	7.6	93	3
38	"	"	"	"	35	300	8.3	93	3
39	"	"	"	"	38	300	9.0	93	3
40	"	"	"	"	32	400	10.1	156	3
41	"	"	"	"	35	400	11.0	156	3
42	"	"	"	"	38	400	12.0	156	3
43	"	"	"	"	32	475	12.0	202	3
44	"	"	"	"	35	475	13.1	202	3
45	"	"	"	"	38	475	14.2	202	3
46	"	"	"	"	32	550	13.9	286	3
47	"	"	"	"	35	550	15.2	286	3
48	"	"	"	"	38	550	16.5	286	3

.../continued

TABLE 1...continued

Submerged Arc Welding with DC Current - Heat Input 3 kJ/mm

MILLER DC 1500 CONSTANT VOLTAGE

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	FLUX TYPE	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
49	Lincoln L60	5/32	Linde 124	DC-	32	400	10.1	42	1
50	"	"	"	"	35	400	11.0	42	1
51	"	"	"	"	38	400	12.0	42	1
52	"	"	"	"	32	600	15.1	73	1
53	"	"	"	"	35	600	16.5	73	1
54	"	"	"	"	38	600	18.0	73	1
55	"	"	"	"	32	800	20.2	101	1
56	"	"	"	"	35	800	22.0	101	1
57	"	"	"	"	38	800	23.9	101	1
58	"	"	"	"	32	1000	25.2	125	1
59	"	"	"	"	35	1000	27.6	125	1
60	"	"	"	"	38	1000	29.9	125	1
61	"	"	"	"	32	400	10.1	43	3
62	"	"	"	"	35	400	11.0	43	3
63	"	"	"	"	38	400	12.0	43	3
64	"	"	"	"	32	600	15.1	83	3
65	"	"	"	"	35	600	16.5	83	3
66	"	"	"	"	38	600	18.0	83	3
67	"	"	"	"	32	800	20.2	121	3
68	"	"	"	"	35	800	22.0	121	3
69	"	"	"	"	38	800	23.9	121	3
70	"	"	"	"	32	1000	25.2	170	3
71	"	"	"	"	35	1000	27.6	170	3
72	"	"	"	"	38	1000	29.9	170	3

.../continued

TABLE 1...continued

Submerged Arc Welding with DC Current - Heat Input 3 kJ/mm

MILLER DC 1500 CONSTANT VOLTAGE

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	FLUX TYPE	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
73	Lincoln L60	5/32	Linde 124	DC+	32	400	10.1	33	1
74	"	"	"	"	35	400	11.0	33	1
75	"	"	"	"	38	400	12.0	33	1
76	"	"	"	"	32	600	15.1	48	1
77	"	"	"	"	35	600	16.5	48	1
78	"	"	"	"	38	600	18.0	48	1
79	"	"	"	"	32	800	20.2	68	1
80	"	"	"	"	35	800	22.0	68	1
81	"	"	"	"	38	800	23.9	68	1
82	"	"	"	"	32	1000	25.2	92	1
83	"	"	"	"	35	1000	27.6	92	1
84	"	"	"	"	38	1000	29.9	92	1
85	"	"	"	"	32	400	10.1	35	3
86	"	"	"	"	35	400	11.0	35	3
87	"	"	"	"	38	400	12.0	35	3
88	"	"	"	"	32	600	15.1	63	3
89	"	"	"	"	35	600	16.5	63	3
90	"	"	"	"	38	600	18.0	63	3
91	"	"	"	"	32	800	20.2	110	3
92	"	"	"	"	35	800	22.0	110	3
93	"	"	"	"	38	800	23.9	110	3
94	"	"	"	"	32	1000	25.2	138	3
95	"	"	"	"	35	1000	27.6	138	3
96	"	"	"	"	38	1000	29.9	138	3

.../continued

TABLE 1...continued

Submerged Arc Welding with DC Current - Heat Input 3 kJ/mm

MILLER DC 1500 CONSTANT VOLTAGE

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	FLUX TYPE	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
97	Lincoln L60	1/8	Linde 124	DC-	32	300	7.6	52	1
98	"	"	"	"	35	300	8.3	52	1
99	"	"	"	"	38	300	9.0	52	1
100	"	"	"	"	32	450	11.3	86	1
101	"	"	"	"	35	450	12.4	86	1
102	"	"	"	"	38	450	13.5	86	1
103	"	"	"	"	32	600	15.1	122	1
104	"	"	"	"	35	600	16.5	122	1
105	"	"	"	"	38	600	18.0	122	1
106	"	"	"	"	32	750	18.9	149	1
107	"	"	"	"	35	750	20.7	149	1
108	"	"	"	"	38	750	22.4	149	1
109	"	"	"	"	32	300	7.6	59	3
110	"	"	"	"	35	300	8.3	59	3
111	"	"	"	"	38	300	9.0	59	3
112	"	"	"	"	32	450	11.3	108	3
113	"	"	"	"	35	450	12.4	108	3
114	"	"	"	"	38	450	13.5	108	3
115	"	"	"	"	32	600	15.1	157	3
116	"	"	"	"	35	600	16.5	157	3
117	"	"	"	"	38	600	18.0	157	3
118	"	"	"	"	32	750	18.9	215	3
119	"	"	"	"	35	750	20.7	215	3
120	"	"	"	"	38	750	22.4	215	3

.../continued

TABLE 1...continued

Submerged Arc Welding with DC Current - Heat Input 3 kJ/mm

MILLER DC 1500 CONSTANT VOLTAGE

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	FLUX TYPE	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
121	Lincoln L60	1/8	Linde 124	DC+	32	300	7.6	40	1
122	"	"	"	"	35	300	8.3	40	1
123	"	"	"	"	38	300	9.0	40	1
124	"	"	"	"	32	450	11.3	58	1
125	"	"	"	"	35	450	12.4	58	1
126	"	"	"	"	38	450	13.5	58	1
127	"	"	"	"	32	600	15.1	77	1
128	"	"	"	"	35	600	16.5	77	1
129	"	"	"	"	38	600	18.0	77	1
130	"	"	"	"	32	750	18.9	103	1
131	"	"	"	"	35	750	20.7	103	1
132	"	"	"	"	38	750	22.4	103	1
133	"	"	"	"	32	300	7.6	50	3
134	"	"	"	"	35	300	8.3	50	3
135	"	"	"	"	38	300	9.0	50	3
136	"	"	"	"	32	450	11.3	79	3
137	"	"	"	"	35	450	12.4	79	3
138	"	"	"	"	38	450	13.5	79	3
139	"	"	"	"	32	600	15.1	123	3
140	"	"	"	"	35	600	16.5	123	3
141	"	"	"	"	38	600	18.0	123	3
142	"	"	"	"	32	750	18.9	171	3
143	"	"	"	"	35	750	20.7	171	3
144	"	"	"	"	38	750	22.4	171	3

.../continued

TABLE 1...continued

Submerged Arc Welding with DC Current - Heat Input 3 kJ/mm

MILLER DC 1500 CONSTANT VOLTAGE

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	FLUX TYPE	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
145	Lincoln L60	1/8	Linde 124	DC-	32	300	7.6	51	1
146	"	"	"	"	35	300	8.3	51	1
147	"	"	"	"	38	300	9.0	51	1
148	"	"	"	"	32	450	11.3	89	1
149	"	"	"	"	35	450	12.4	89	1
150	"	"	"	"	38	450	13.5	89	1
151	"	"	"	"	32	600	15.1	122	1
152	"	"	"	"	35	600	16.5	122	1
153	"	"	"	"	38	600	18.0	122	1
154	"	"	"	"	32	750	18.9	149	1
155	"	"	"	"	35	750	20.7	149	1
156	"	"	"	"	38	750	22.4	149	1
157	"	"	"	"	32	300	7.6	60	3
158	"	"	"	"	35	300	8.3	60	3
159	"	"	"	"	38	300	9.0	60	3
160	"	"	"	"	32	450	11.3	106	3
161	"	"	"	"	35	450	12.4	106	3
162	"	"	"	"	38	450	13.5	106	3
163	"	"	"	"	32	600	15.1	153	3
164	"	"	"	"	35	600	16.5	153	3
165	"	"	"	"	38	600	18.0	153	3
166	"	"	"	"	32	750	18.9	215	3
167	"	"	"	"	35	750	20.7	215	3
168	"	"	"	"	38	750	22.4	215	3

.../continued

TABLE 1...continued

Submerged Arc Welding with DC Current - Heat Input 3 kJ/mm

MILLER DC 1500 CONSTANT VOLTAGE

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	FLUX TYPE	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
169	Lincoln L60	1/8	Linde 124	DC+	32	300	7.6	39	1
170	"	"	"	"	35	300	8.3	39	1
171	"	"	"	"	38	300	9.0	39	1
172	"	"	"	"	32	450	11.3	59	1
173	"	"	"	"	35	450	12.4	59	1
174	"	"	"	"	38	450	13.5	59	1
175	"	"	"	"	32	600	15.1	82	1
176	"	"	"	"	35	600	16.5	82	1
177	"	"	"	"	38	600	18.0	82	1
178	"	"	"	"	32	750	18.9	108	1
179	"	"	"	"	35	750	20.7	108	1
180	"	"	"	"	38	750	22.4	108	1
181	"	"	"	"	32	300	7.6	47	3
182	"	"	"	"	35	300	8.3	47	3
183	"	"	"	"	38	300	9.0	47	3
184	"	"	"	"	32	450	11.3	75	3
185	"	"	"	"	35	450	12.4	75	3
186	"	"	"	"	38	450	13.5	75	3
187	"	"	"	"	32	600	15.1	120	3
188	"	"	"	"	35	600	16.5	120	3
189	"	"	"	"	38	600	18.0	120	3
190	"	"	"	"	32	750	18.9	185	3
191	"	"	"	"	35	750	20.7	185	3
192	"	"	"	"	38	750	22.4	185	3

.../continued

TABLE 1...continued

Submerged Arc Welding with DC Current - Heat Input 3 kJ/mm

MILLER DC 1500 CONSTANT VOLTAGE

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	FLUX TYPE	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
193	Lincoln L60	1/8	OP121TT	DC-	32	300	7.6	64	1
194	"	"	"	"	35	300	8.3	64	1
195	"	"	"	"	38	300	9.0	64	1
196	"	"	"	"	32	450	11.3	91	1
197	"	"	"	"	35	450	12.4	91	1
198	"	"	"	"	38	450	13.5	91	1
199	"	"	"	"	32	600	15.1	120	1
200	"	"	"	"	35	600	16.5	120	1
201	"	"	"	"	38	600	18.0	120	1
202	"	"	"	"	32	750	18.9	155	1
203	"	"	"	"	35	750	20.7	155	1
204	"	"	"	"	38	750	22.4	155	1
205	"	"	"	"	32	300	7.6	66	3
206	"	"	"	"	35	300	8.3	66	3
207	"	"	"	"	38	300	9.0	66	3
208	"	"	"	"	32	450	11.3	105	3
209	"	"	"	"	35	450	12.4	105	3
210	"	"	"	"	38	450	13.5	105	3
211	"	"	"	"	32	600	15.1	148	3
212	"	"	"	"	35	600	16.5	148	3
213	"	"	"	"	38	600	18.0	148	3
214	"	"	"	"	32	750	18.9	217	3
215	"	"	"	"	35	750	20.7	217	3
216	"	"	"	"	38	750	22.4	217	3

.../continued

TABLE 1...continued

Submerged Arc Welding with DC Current - Heat Input 3 kJ/mm

MILLER DC 1500 CONSTANT VOLTAGE

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	FLUX TYPE	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
217	Lincoln L60	1/8	OP121TT	DC+	32	300	7.6	37	1
218	"	"	"	"	35	300	8.3	37	1
219	"	"	"	"	38	300	9.0	37	1
220	"	"	"	"	32	450	11.3	54	1
221	"	"	"	"	35	450	12.4	54	1
222	"	"	"	"	38	450	13.5	54	1
223	"	"	"	"	32	600	15.1	73	1
224	"	"	"	"	35	600	16.5	73	1
225	"	"	"	"	38	600	18.0	73	1
226	"	"	"	"	32	750	18.9	102	1
227	"	"	"	"	35	750	20.7	102	1
228	"	"	"	"	38	750	22.4	102	1
229	"	"	"	"	32	300	7.6	46	3
230	"	"	"	"	35	300	8.3	46	3
231	"	"	"	"	38	300	9.0	46	3
232	"	"	"	"	32	450	11.3	85	3
233	"	"	"	"	35	450	12.4	85	3
234	"	"	"	"	38	450	13.5	85	3
235	"	"	"	"	32	600	15.1	126	3
236	"	"	"	"	35	600	16.5	126	3
237	"	"	"	"	38	600	18.0	126	3
238	"	"	"	"	32	750	18.9	198	3
239	"	"	"	"	35	750	20.7	198	3
240	"	"	"	"	38	750	22.4	198	3

.../continued

TABLE 1...continued

Submerged Arc Welding with DC Current - Heat Input 3 kJ/mm

MILLER DC 1500 CONSTANT VOLTAGE

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	FLUX TYPE	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
241	Lincoln L60	1/8	OP121TT	DC-	32	300	7.6	65	1
242	"	"	"	"	35	300	8.3	65	1
243	"	"	"	"	38	300	9.0	65	1
244	"	"	"	"	32	450	11.3	92	1
245	"	"	"	"	35	450	12.4	92	1
246	"	"	"	"	38	450	13.5	92	1
247	"	"	"	"	32	600	15.1	119	1
248	"	"	"	"	35	600	16.5	119	1
249	"	"	"	"	38	600	18.0	119	1
250	"	"	"	"	32	750	18.9	152	1
251	"	"	"	"	35	750	20.7	152	1
252	"	"	"	"	38	750	22.4	152	1
253	"	"	"	"	32	300	7.6	67	3
254	"	"	"	"	35	300	8.3	67	3
255	"	"	"	"	38	300	9.0	67	3
256	"	"	"	"	32	450	11.3	111	3
257	"	"	"	"	35	450	12.4	111	3
258	"	"	"	"	38	450	13.5	111	3
259	"	"	"	"	32	600	15.1	151	3
260	"	"	"	"	35	600	16.5	151	3
261	"	"	"	"	38	600	18.0	151	3
262	"	"	"	"	32	750	18.9	215	3
263	"	"	"	"	35	750	20.7	215	3
264	"	"	"	"	38	750	22.4	215	3

.../continued

TABLE 1...continued

Submerged Arc Welding with DC Current - Heat Input 3 kJ/mm

MILLER DC 1500 CONSTANT VOLTAGE

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	FLUX TYPE	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
265	Lincoln L60	1/8	OP121TT	DC+	32	300	7.6	38	1
266	"	"	"	"	35	300	8.3	38	1
267	"	"	"	"	38	300	9.0	38	1
268	"	"	"	"	32	450	11.3	59	1
269	"	"	"	"	35	450	12.4	59	1
270	"	"	"	"	38	450	13.5	59	1
271	"	"	"	"	32	600	15.1	82	1
272	"	"	"	"	35	600	16.5	82	1
273	"	"	"	"	38	600	18.0	82	1
274	"	"	"	"	32	750	18.9	108	1
275	"	"	"	"	35	750	20.7	108	1
276	"	"	"	"	38	750	22.4	108	1
277	"	"	"	"	32	300	7.6	45	3
278	"	"	"	"	35	300	8.3	45	3
279	"	"	"	"	38	300	9.0	45	3
280	"	"	"	"	32	450	11.3	80	3
281	"	"	"	"	35	450	12.4	80	3
282	"	"	"	"	38	450	13.5	80	3
283	"	"	"	"	32	600	15.1	131	3
284	"	"	"	"	35	600	16.5	131	3
285	"	"	"	"	38	600	18.0	131	3
286	"	"	"	"	32	750	18.9	186	3
287	"	"	"	"	35	750	20.7	186	3
288	"	"	"	"	38	750	22.4	186	3

TABLE 2: RELATIONSHIP BETWEEN PROCESS PARAMETERS AND WIRE FEED SPEED FOR ARC WELDING PROCESS

Submerged Arc Welding with AC Current - Heat Input 3kJ/mm

MILLER AC SQUARE WAVE 1000

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	FLUX TYPE	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
289	Lincoln L60	5/32	Linde 124	32	450	11.3	38	1
290	"	"	"	32	550	13.9	50	1
291	"	"	"	32	650	16.4	60	1
292	"	"	"	32	750	18.9	76	1
293	"	"	"	36	450	12.8	35	1
294	"	"	"	36	550	15.6	45	1
295	"	"	"	36	650	18.4	55	1
296	"	"	"	36	750	21.3	65	1
297	"	"	"	32	450	11.3	40	3
298	"	"	"	32	550	13.9	55	3
299	"	"	"	32	650	16.4	80	3
300	"	"	"	32	750	18.9	95	3
301	"	"	"	36	450	12.8	40	3
302	"	"	"	36	550	15.6	55	3
303	"	"	"	36	650	18.4	70	3
304	"	"	"	36	750	21.3	85	3
305	"	1/8	"	30	400	9.4	50	1
306	"	"	"	30	500	11.8	56	1
307	"	"	"	30	600	14.2	93	1
308	"	"	"	30	700	16.5	120	1
309	"	"	"	34	400	10.7	50	1
310	"	"	"	34	500	13.4	60	1
311	"	"	"	34	600	16.1	85	1
312	"	"	"	34	700	18.7	105	1

.../continued

TABLE 2...continued

Submerged Arc Welding with AC Current - Heat Input 3kJ/mm

MILLER AC SQUARE WAVE 1000

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	FLUX TYPE	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
313	Lincoln L60	1/8	Linde 124	30	400	9.4	55	3
314	"	"	"	30	500	11.8	85	3
315	"	"	"	30	600	14.2	120	3
316	"	"	"	30	700	16.5	160	3
317	"	"	"	34	400	10.7	60	3
318	"	"	"	34	500	13.4	85	3
319	"	"	"	34	600	16.1	115	3
320	"	"	"	34	700	18.7	160	3
321	"	"	OP121TT	30	400	9.4	55	1
322	"	"	"	30	500	11.8	70	1
323	"	"	"	30	600	14.2	95	1
324	"	"	"	30	700	16.5	115	1
325	"	"	"	34	400	10.7	55	1
326	"	"	"	34	500	13.4	70	1
327	"	"	"	34	600	16.1	85	1
328	"	"	"	34	700	18.7	105	1
329	"	"	"	30	400	9.4	65	3
330	"	"	"	30	500	11.8	90	3
331	"	"	"	30	600	14.2	125	3
332	"	"	"	30	700	16.5	170	3
333	"	"	"	34	400	10.7	67	3
334	"	"	"	34	500	13.4	90	3
335	"	"	"	34	600	16.1	120	3
336	"	"	"	34	700	18.7	160	3

.../continued

TABLE 2...continued

Submerged Arc Welding with AC Current - Heat Input 3kJ/mm

AC SQUARE WAVE 1000

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	GAS SHIELDING	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
337	Lincoln L60	1/8	OP121TT	AC	Weld not made				1
338	Lincoln L60	1/8	OP121TT	AC	Weld not made				1
339	Lincoln L60	1/8	OP121TT	AC	Weld not made				1
340	Lincoln L60	1/8	OP121TT	AC	Weld not made				1

TABLE 3: RELATIONSHIP BETWEEN PROCESS PARAMETERS AND WIRE FEED SPEED FOR ARC WELDING PROCESSES

Gas Metal Arc Welding with DC Current - Heat Input 1 kJ/mm

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	GAS SHIELDING	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
341	Linde 86	0.035	C-25	DC+	29	140	9.5	290	5/8
342	" "	0.035	C-25	DC+	29	190	13	490	5/8
343	" "	0.035	C-25	DC+	29	240	16.4	758	5/8
344	" "	0.035	C-25	DC+	24	140	8.0	325	5/8
345	" "	0.035	C-25	DC+	24	190	10.8	515	5/8
346	" "	0.035	C-25	DC+	24	240	13.6	795	5/8
347	" "	0.035	C-15	DC+	29	140	9.5	270	5/8
348	" "	0.035	C-15	DC+	29	190	13	465	5/8
349	" "	0.035	C-15	DC+	29	240	16.4	703	5/8
350	" "	0.035	C-15	DC+	24	140	8.0	305	5/8
351	" "	0.035	C-15	DC+	24	190	10.8	498	5/8
352	" "	0.035	C-15	DC+	24	240	13.6	760	5/8
353	" "	0.035	M-2	DC+	29	140	9.5	263	5/8
354	" "	0.035	M-2	DC+	29	190	13	384	5/8
355	" "	0.035	M-2	DC+	29	240	16.4	625	5/8
356	" "	0.035	M-2	DC+	24	140	8.0	288	5/8
357	" "	0.035	M-2	DC+	24	190	10.8	467	5/8
358	" "	0.035	M-2	DC+	24	240	13.6	736	5/8
359	" "	0.035	C-25	DC+	29	140	9.5	466	1⅛
360	" "	0.035	C-25	DC+	29	190	13	825	1⅛
361	" "	0.035	C-25	DC+	29	240	16.4		1⅛
362	" "	0.035	C-25	DC+	24	140	8.0	493	1⅛
363	" "	0.035	C-25	DC+	24	190	10.8		1⅛
364	" "	0.035	C-25	DC+	24	240	13.6		1⅛

* Max. Amperage Obtained.
**Max. Amperage Obtained & No Section Cut Due To Erratic Bead.

.../continued

TABLE 3...continued

Gas Metal Arc Welding with DC Current - Heat Input 1 kJ/mm

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	GAS SHIELDING	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)	
365	Linde 86	0.035	C-15	DC+	29	140	9.5	460	1¼	
366	" "	0.035	C-15	DC+	29	190	13	806	1¼	
367	" "	0.035	C-15	DC+	29	240	16.4		1¼	
368	" "	0.035	C-15	DC+	24	140	8.0	483	1¼	
369	" "	0.035	C-15	DC+	24	190	10.8		1¼	
370	" "	0.035	C-15	DC+	24	240	13.6		1¼	
371	" "	0.035	M-2	DC+	29	140	9.5	421	1¼	
372	" "	0.035	M-2	DC+	29	190	13	766	1¼	
373	" "	0.035	M-2	DC+	29	240	16.4		1¼	
374	" "	0.035	M-2	DC+	24	140	8.0	472	1¼	
375	" "	0.035	M-2	DC+	24	190	10.8	830	1¼	
376	" "	0.035	M-2	DC+	24	240	13.6		1¼	
377	" "	0.035	C-25	DC-	29	140	9.5	405	5/8	
378	" "	0.035	C-25	DC-	29	190	13	624	5/8	
379	" "	0.035	C-25	DC-	29	230	16.4	848	5/8	*
380	" "	0.035	C-25	DC-	24	140	8.0	450	5/8	
381	" "	0.035	C-25	DC-	24	190	10.8	624	5/8	
382	" "	0.035	C-25	DC-	24	235	13.6	862	5/8	*
383	" "	0.035	C-15	DC-	29	140	9.5	398	5/8	
384	" "	0.035	C-15	DC-	29	190	13	618	5/8	
385	" "	0.035	C-15	DC-	29	230	16.4	835	5/8	*
386	" "	0.035	C-15	DC-	24	140	8.0	444	5/8	
387	" "	0.035	C-15	DC-	24	190	10.8	650	5/8	
388	" "	0.035	C-15	DC-	24	235	13.6	854	5/8	*

* Max. Amperage Obtained.
**Max. Amperage Obtained & No Section Cut Due To Erratic Bead.

.../continued

TABLE 3...continued

Gas Metal Arc Welding with DC Current - Heat Input 1 kJ/mm

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	GAS SHIELDING	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)	
389	Linde 86	0.035	M-2	DC-	29	140	9.5		5/8	
390	" "	0.035	M-2	DC-	29	190	13		5/8	
391	" "	0.035	M-2	DC-	29	230	16.4	838	5/8	*
392	" "	0.035	M-2	DC-	24	140	8.0	475	5/8	
393	" "	0.035	M-2	DC-	24	190	10.8	695	5/8	
394	" "	0.035	M-2	DC-	24	225	13.6	860	5/8	*
395	" "	0.035	C-25	DC-	29	140	9.5	615	1¼	
396	" "	0.035	C-25	DC-	29	175	13	856	1¼	*
397	" "	0.035	C-25	DC-	29	175	16.4	852	1¼	*
398	" "	0.035	C-25	DC-	24	140	8.0	604	1¼	
399	" "	0.035	C-25	DC-	24	175	10.8	860	1¼	**
400	" "	0.035	C-25	DC-	24	160	13.6	862	1¼	**
401	" "	0.035	C-15	DC-	29	140	9.5	596	1¼	
402	" "	0.035	C-15	DC-	29	180	13	858	1¼	*
403	" "	0.035	C-15	DC-	29	175	16.4	856	1¼	*
404	" "	0.035	C-15	DC-	24	140	8.0	617	1¼	
405	" "	0.035	C-15	DC-	24	150	10.8	690	1¼	*
406	" "	0.035	C-15	DC-	24	130	13.6	565	1¼	**
407	" "	0.035	M-2	DC-	29	140	9.5	564	1¼	
408	" "	0.035	M-2	DC-	29	180	13	856	1¼	*
409	" "	0.035	M-2	DC-	29	180	16.4	860	1¼	*
410	" "	0.035	M-2	DC-	24	140	8.0	600	1¼	
411	" "	0.035	M-2	DC-	24	140	10.8	600	1¼	**
412	" "	0.035	M-2	DC-	24	140	13.6	593	1¼	**

* Max. Amperage Obtained.
**Max. Amperage Obtained & No Section Cut Due To Erratic Bead.

.../continued

TABLE 3...continued

Gas Metal Arc Welding with DC Current

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	GAS SHIELDING	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)	
413	Linde 86	0.045	C-25	DC+	29	250	9	327	5/8	
414	" "	0.045	C-25	DC+	29	300	9	463	5/8	
415	" "	0.045	C-25	DC+	29	350	9	634	5/8	
416	" "	0.045	C-25	DC+	24	250	9	361	5/8	
417	" "	0.045	C-25	DC+	24	300	9	522	5/8	
418	" "	0.045	C-25	DC+	24	350	9	713	5/8	
419	" "	0.045	C-25	DC+	29	250	13.7	343	5/8	
420	" "	0.045	C-25	DC+	29	300	13.7	482	5/8	
421	" "	0.045	C-25	DC+	29	350	13.7	650	5/8	
422	" "	0.045	C-25	DC+	24	250	13.7	380	5/8	
423	" "	0.045	C-25	DC+	24	300	13.7	531	5/8	
424	" "	0.045	C-25	DC+	24	350	13.7	698	5/8	
425	" "	0.045	C-25	DC+	29	250	9	523	1¼	
426	" "	0.045	C-25	DC+	29	300	9	726	1¼	
427	" "	0.045	C-25	DC+	29	320	9	823	1¼	*
428	" "	0.045	C-25	DC+	24	250	9	551	1¼	
429	" "	0.045	C-25	DC+	24	300	9	762	1¼	
430	" "	0.045	C-25	DC+	24	310	9	823	1¼	*
431	" "	0.045	C-25	DC+	29	250	13.7	522	1¼	
432	" "	0.045	C-25	DC+	29	300	13.7	752	1¼	
433	" "	0.045	C-25	DC+	29	312	13.7	824	1¼	*
434	" "	0.045	C-25	DC+	24	250	13.7	560	1¼	
435	" "	0.045	C-25	DC+	24	300	13.7	790	1¼	
436	" "	0.045	C-25	DC+	24	304	13.7	824	1¼	*

* Max. Amperage Obtained.
**Max. Amperage Obtained and No Section Cut Due to Erratic Bead.

.../continued

TABLE 3...continued

Gas Metal Arc Welding with DC Current

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	GAS SHIELDING	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)	
437	Linde 86	0.045	C-25	DC-	29	250	9	655	1¼	
438	" "	0.045	C-25	DC-	29	296	9	821	1¼	*
439	" "	0.045	C-25	DC-	29	350	9		1¼	*
440	" "	0.045	C-25	DC-	24	250	9	636	1¼	
441	" "	0.045	C-25	DC-	24	280	9	822	1¼	*
442	" "	0.045	C-25	DC-	24	350	9		1¼	*
443	" "	0.045	C-25	DC-	29	250	13.7	657	1¼	
444	" "	0.045	C-25	DC-	29	290	13.7	822	1¼	*
445	" "	0.045	C-25	DC-	29	350	13.7		1¼	*
446	" "	0.045	C-25	DC-	24	250	13.7	661	1¼	
447	" "	0.045	C-25	DC-	24	275	13.7	822	1¼	*
448	" "	0.045	C-25	DC-	24	350	13.7		1¼	**
449	" "	0.045	C-25	DC-	29	250	9	507	5/8	
450	" "	0.045	C-25	DC-	29	300	9	587	5/8	
451	" "	0.045	C-25	DC-	29	350	9	716	5/8	
452	" "	0.045	C-25	DC-	24	250	9	502	5/8	
453	" "	0.045	C-25	DC-	24	300	9	622	5/8	
454	" "	0.045	C-25	DC-	24	350	9	731	5/8	
455	" "	0.045	C-25	DC-	29	250	13.7	502	5/8	
456	" "	0.045	C-25	DC-	29	300	13.7	606	5/8	
457	" "	0.045	C-25	DC-	29	350	13.7	724	5/8	
458	" "	0.045	C-25	DC-	24	250	13.7	496	5/8	
459	" "	0.045	C-25	DC-	24	300	13.7	628	5/8	
460	" "	0.045	C-25	DC-	24	350	13.7	804	5/8	

* Max. Amperage Obtained.
**Max. Amperage Obtained and No Section Cut Due to Erratic Bead.

.../continued

TABLE 3...continued

Gas Metal Arc Welding with DC Current

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	GAS SHIELDING	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)	
461	Linde 86	0.045	M-2	DC+	29	250	9	357	5/8	
462	" "	0.045	M-2	DC+	29	300	9	515	5/8	
463	" "	0.045	M-2	DC+	29	350	9	670	5/8	
464	" "	0.045	M-2	DC+	24	250	9	356	5/8	
465	" "	0.045	M-2	DC+	24	300	9	502	5/8	
466	" "	0.045	M-2	DC+	24	350	9	647	5/8	
467	" "	0.045	M-2	DC+	29	250	13.7	332	5/8	
468	" "	0.045	M-2	DC+	29	300	13.7	487	5/8	
469	" "	0.045	M-2	DC+	29	350	13.7	664	5/8	
470	" "	0.045	M-2	DC+	24	250	13.7	368	5/8	
471	" "	0.045	M-2	DC+	24	300	13.7	503	5/8	
472	" "	0.045	M-2	DC+	24	350	13.7	636	5/8	
473	" "	0.045	M-2	DC+	29	250	9	553	1¼	
474	" "	0.045	M-2	DC+	29	300	9	760	1¼	
475	" "	0.045	M-2	DC+	29	316	9	821	1¼	*
476	" "	0.045	M-2	DC+	24	250	9	554	1¼	
477	" "	0.045	M-2	DC+	24	300	9	747	1¼	
478	" "	0.045	M-2	DC+	24	316	9	819	1¼	*
479	" "	0.045	M-2	DC+	29	250	13.7	572	1¼	
480	" "	0.045	M-2	DC+	29	300	13.7	756	1¼	
481	" "	0.045	M-2	DC+	29	316	13.7	821	1¼	*
482	" "	0.045	M-2	DC+	24	250	13.7	563	1¼	
483	" "	0.045	M-2	DC+	24	300	13.7	768	1¼	
484	" "	0.045	M-2	DC+	24	310	13.7	822	1¼	*

* Max. Amperage Obtained.
**Max. Amperage Obtained and No Section Cut Due to Erratic Bead.

.../continued

TABLE 3...continued

Gas Metal Arc Welding with DC Current

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	GAS SHIELDING	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)	
485	Linde 86	0.045	M-2	DC-	29	250	9	636	1¼	
486	" "	0.045	M-2	DC-	29	300	9	820	1¼	
487	" "	0.045	M-2	DC-	29	305	9	822	1¼	*
488	" "	0.045	M-2	DC-	24	250	9	637	1¼	
489	" "	0.045	M-2	DC-	24	300	9	820	1¼	
490	" "	0.045	M-2	DC-	24	305	9	822	1¼	*
491	" "	0.045	M-2	DC-	29	250	13.7	624	1¼	
492	" "	0.045	M-2	DC-	29	300	13.7	804	1¼	
493	" "	0.045	M-2	DC-	29	305	13.7	822	1¼	*
494	" "	0.045	M-2	DC-	24	250	13.7	660	1¼	
495	" "	0.045	M-2	DC-	24	260	13.7	822	1¼	*
496	" "	0.045	M-2	DC-	24	260	13.7	822	1¼	*
497	" "	0.045	M-2	DC-	29	250	9	465	5/8	
498	" "	0.045	M-2	DC-	29	350	9	556	5/8	
499	" "	0.045	M-2	DC-	29	350	9	671	5/8	
500	" "	0.045	M-2	DC-	24	250	9	502	5/8	
501	" "	0.045	M-2	DC-	24	300	9	619	5/8	
502	" "	0.045	M-2	DC-	24	350	9	755	5/8	
503	" "	0.045	M-2	DC-	29	250	13.7	463	5/8	
504	" "	0.045	M-2	DC-	29	300	13.7	556	5/8	
505	" "	0.045	M-2	DC-	29	350	13.7	697	5/8	
506	" "	0.045	M-2	DC-	24	250	13.7	518	5/8	
507	" "	0.045	M-2	DC-	24	300	13.7	629	5/8	
508	" "	0.045	M-2	DC-	24	350	13.7	765	5/8	

* Max. Amperage Obtained.
**Max. Amperage Obtained and No Section Cut Due to Erratic Bead.

.../continued

TABLE 3...continued

Gas Metal Arc Welding with DC Current

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	GAS SHIELDING	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
509	Linde 86	1/16	C-25	DC+	32	300	10	158	5/8
510	" "	1/16	C-25	DC+	32	350	10	190	5/8
511	" "	1/16	C-25	DC+	32	400	10	258	5/8
512	" "	1/16	C-25	DC+	27	300	10	180	5/8
513	" "	1/16	C-25	DC+	27	350	10	228	5/8
514	" "	1/16	C-25	DC+	27	400	10	297	5/8
515	" "	1/16	C-25	DC+	32	300	15	150	5/8
516	" "	1/16	C-25	DC+	32	350	15	196	5/8
517	" "	1/16	C-25	DC+	32	400	15	251	5/8
518	" "	1/16	C-25	DC+	27	300	15	181	5/8
519	" "	1/16	C-25	DC+	27	350	15	225	5/8
520	" "	1/16	C-25	DC+	27	400	15	283	5/8
521	" "	1/16	C-25	DC+	32	300	10	225	1¼
522	" "	1/16	C-25	DC+	32	350	10	282	1¼
523	" "	1/16	C-25	DC+	32	400	10	377	1¼
524	" "	1/16	C-25	DC+	27	300	10	258	1¼
525	" "	1/16	C-25	DC+	27	350	10	317	1¼
526	" "	1/16	C-25	DC+	27	400	10	423	1¼
527	" "	1/16	C-25	DC+	32	300	15	230	1¼
528	" "	1/16	C-25	DC+	32	350	15	282	1¼
529	" "	1/16	C-25	DC+	32	400	15	372	1¼
530	" "	1/16	C-25	DC+	27	300	15	256	1¼
531	" "	1/16	C-25	DC+	27	350	15	320	1¼
532	" "	1/16	C-25	DC+	27	400	15	416	1¼

.../continued

TABLE 3...continued

Gas Metal Arc Welding with DC Current

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	GAS SHIELDING	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
533	Linde 86	1/16	C-25	DC-	32	300	10	330	1¼
534	" "	1/16	C-25	DC-	32	350	10	397	1¼
535	" "	1/16	C-25	DC-	32	400	10	457	1¼
536	" "	1/16	C-25	DC-	27	300	10	334	1¼
537	" "	1/16	C-25	DC-	27	350	10	413	1¼
538	" "	1/16	C-25	DC-	27	400	10	496	1¼
539	" "	1/16	C-25	DC-	32	300	15	323	1¼
540	" "	1/16	C-25	DC-	32	350	15	388	1¼
541	" "	1/16	C-25	DC-	32	400	15	468	1¼
542	" "	1/16	C-25	DC-	27	300	15	340	1¼
543	" "	1/16	C-25	DC-	27	350	15	417	1¼
544	" "	1/16	C-25	DC-	27	400	15	500	1¼
545	" "	1/16	C-25	DC-	32	300	10	275	5/8
546	" "	1/16	C-25	DC-	32	350	10	325	5/8
547	" "	1/16	C-25	DC-	32	400	10	366	5/8
548	" "	1/16	C-25	DC-	27	300	10	286	5/8
549	" "	1/16	C-25	DC-	27	350	10	337	5/8
550	" "	1/16	C-25	DC-	27	400	10	376	5/8
551	" "	1/16	C-25	DC-	32	300	15	270	5/8
552	" "	1/16	C-25	DC-	32	350	15	325	5/8
553	" "	1/16	C-25	DC-	32	400	15	362	5/8
554	" "	1/16	C-25	DC-	27	300	15	285	5/8
555	" "	1/16	C-25	DC-	27	350	15	330	5/8
556	" "	1/16	C-25	DC-	27	400	15	386	5/8

.../continued

TABLE 3...continued

Gas Metal Arc Welding with DC Current

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	GAS SHIELDING	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
557	Linde 86	1/16	M-2	DC+	32	300	10		5/8
558	" "	1/16	M-2	DC+	32	350	10		5/8
559	" "	1/16	M-2	DC+	32	400	10		5/8
560	" "	1/16	M-2	DC+	27	300	10	150	5/8
561	" "	1/16	M-2	DC+	27	350	10	182	5/8
562	" "	1/16	M-2	DC+	27	400	10	225	5/8
563	" "	1/16	M-2	DC+	32	300	15		5/8
564	" "	1/16	M-2	DC+	32	350	15		5/8
565	" "	1/16	M-2	DC+	32	400	15		5/8
566	" "	1/16	M-2	DC+	27	300	15	155	5/8
567	" "	1/16	M-2	DC+	27	350	15	184	5/8
568	" "	1/16	M-2	DC+	27	400	15	235	5/8
569	" "	1/16	M-2	DC+	32	300	10	188	1¼
570	" "	1/16	M-2	DC+	32	350	10	235	1¼
571	" "	1/16	M-2	DC+	32	400	10	302	1¼
572	" "	1/16	M-2	DC+	27	300	10	215	1¼
573	" "	1/16	M-2	DC+	27	350	10	295	1¼
574	" "	1/16	M-2	DC+	27	400	10	393	1¼
575	" "	1/16	M-2	DC+	32	300	15	185	1¼
576	" "	1/16	M-2	DC+	32	350	15	240	1¼
577	" "	1/16	M-2	DC+	32	400	15	324	1¼
578	" "	1/16	M-2	DC+	27	300	15	221	1¼
579	" "	1/16	M-2	DC+	27	350	15	298	1¼
580	" "	1/16	M-2	DC+	27	400	15	376	1¼

.../continued

TABLE 3...continued

Gas Metal Arc Welding with DC Current

WELD I.D. NO.	WIRE TYPE	WIRE DIA. (IN.)	GAS SHIELDING	POLARITY	VOLTAGE (VOLTS)	CURRENT (AMPS)	TRAVEL SPEED (IPM)	WFS (IN/MIN)	ESO (IN.)
581	Linde 86	1/16	M-2	DC-	32	300	10	317	1¼
582	" "	1/16	M-2	DC-	32	350	10	388	1¼
583	" "	1/16	M-2	DC-	32	400	10	449	1¼
584	" "	1/16	M-2	DC-	27	300	10	354	1¼
585	" "	1/16	M-2	DC-	27	350	10	418	1¼
586	" "	1/16	M-2	DC-	27	400	10	513	1¼
587	" "	1/16	M-2	DC-	32	300	15	319	1¼
588	" "	1/16	M-2	DC-	32	350	15	383	1¼
589	" "	1/16	M-2	DC-	32	400	15	466	1¼
590	" "	1/16	M-2	DC-	27	300	15	356	1¼
591	" "	1/16	M-2	DC-	27	350	15	425	1¼
592	" "	1/16	M-2	DC-	27	400	15	518	1¼
593	" "	1/16	M-2	DC-	32	300	10		5/8
594	" "	1/16	M-2	DC-	32	350	10		5/8
595	" "	1/16	M-2	DC-	32	400	10		5/8
596	" "	1/16	M-2	DC-	27	300	10	286	5/8
597	" "	1/16	M-2	DC-	27	350	10	338	5/8
598	" "	1/16	M-2	DC-	27	400	10	408	5/8
599	" "	1/16	M-2	DC-	32	300	15		5/8
600	" "	1/16	M-2	DC-	32	350	15		5/8
601	" "	1/16	M-2	DC-	32	400	15		5/8
602	" "	1/16	M-2	DC-	27	300	15	290	5/8
603	" "	1/16	M-2	DC-	27	350	15	336	5/8
604	" "	1/16	M-2	DC-	27	400	15	403	5/8

TABLE 4: BEAD SHAPE MEASUREMENTS

Weld I.D. No.	Bead Width (x) (mm)	Deposited Bead Height (Y_1) (mm)	Fused Bead Penetration (Y_2) (mm)	Deposited Area (A_1) (mm^2)	Fused Area (A_2) (mm^2)	Length of Fused Boundary (L_2) (mm)
1	13.7	4.6	3.6	47.83	27.77	--
2	15.8	4.5	3.3	51.56	25.53	--
3	14.9	4.2	3.1	44.59	22.63	--
4	16.2	4.5	4.1	54.68	32.55	--
5	17.1	3.7	4.4	48.03	39.17	--
6	16.3	3.5	4.0	40.98	35.37	--
7	16.1	4.9	6.7	59.00	62.82	--
8	16.8	4.7	5.7	54.14	45.98	21.2
9	18.4	3.6	5.3	47.77	50.22	--
10	15.6	4.8	2.7	53.33	27.66	
11	15.6	4.5	8.3	52.51	52.06	--
12	17.1	3.4	7.2	42.34	70.56	--
13	15.1	4.8	3.1	62.25	24.50	--
14	11.8	8.4	12.2	93.10	96.82	--
15	16.5	4.9	3.4	59.40	23.09	--
16	13.0	7.5	7.4	86.92	52.74	--
17	16.2	5.6	6.5	66.80	57.98	--
18	16.3	5.0	6.7	62.81	61.83	--
19	10.6	7.3	11.3	75.92	72.28	--
20	11.9	7.3	9.6	77.87	70.62	--
21	13.4	7.3	9.4	80.35	75.81	--
22	11.2	11.2	10.8	130.23	64.71	--
23	12.5	5.6	10.8	62.22	79.91	--
24	10.8	7.5	12.2	75.35	82.87	--
25						
26	20.2	2.2	4.5	30.44	47.99	--
27	16.3	2.7	3.7	28.14	32.99	--
28	15.7	3.2	6.2	36.90	55.90	--
29	17.8	2.4	5.4	32.36	47.90	--
30	17.8	2.9	5.4	33.07	49.38	--
31	17.5	3.7	7.1	46.52	66.29	--
32						
33	17.7	3.1	6.5	34.42	63.12	--
34	16.4	4.6		52.31		--
35						
36	17.1	2.7	8.8	31.08	81.71	--
37	15.8	4.6	5.3	50.45	42.80	--
38	16.4	4.1	4.6	45.81	38.87	--
39	15.4	3.7	4.4	38.90	36.64	--
40	13.9	5.8	7.5	60.60	62.04	--
41	14.6	5.1	8.1	60.73	65.68	--
42	18.6	4.3	6.6	54.51	58.53	--
43	12.3	6.0	11.2	62.89	78.43	27.5
44	15.5	6.2	9.9	74.48	80.80	--
45	15.2	4.9	9.0	60.47	76.31	--
46	10.2	10.5	14.2	106.15	80.73	--

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Table 4...continued

Weld I.D. No.	Bead Width (x) (mm)	Deposited Bead Height (Y_1) (mm)	Fused Bead Penetration (Y_2) (mm)	Deposited Area (A_1) (mm^2)	Fused Area (A_2) (mm^2)	Fused Boundary (L_2) (mm)
47	17.4	4.9	3.3	62.22	25.54	--
48	14.7	6.3	10.1	73.78	79.62	--
49	15.4	3.7	3.9	41.48	32.80	--
50	16.9	3.5	4.1	41.75	32.70	--
51						
52	17.3	4.3	6.3	56.39	61.57	--
53	17.4	3.9	6.5	48.75	58.89	22.9
54	18.1	3.1	5.8	39.74	58.55	--
55	10.7	4.6	11.9	38.71	90.13	--
56	14.5	5.2	10.8	63.10	96.78	--
57	11.5	3.3	10.6	28.58	89.77	--
58	10.2	7.0	12.3	59.14	102.50	--
59	12.4	6.6	12.5	67.13	106.78	--
60	13.1	6.6	11.9	65.25	116.41	--
61	17.2	4.0	3.8	50.29	36.26	--
62	15.4	3.8	4.5	38.91	39.82	--
63	15.8	3.7	3.7	40.80	33.17	--
64	17.7	5.3	6.0	71.24	63.60	--
65	18.4	3.7	6.6	49.03	68.47	--
66	19.6	3.3	6.5	47.89	67.83	--
67	11.9	8.2	11.1	84.80	88.71	--
68	12.7	5.9	9.8	54.81	91.35	
69	15.2	4.6	9.6	54.28	97.22	--
70	10.3	8.5	11.5	81.95	81.35	--
71	11.8	9.4	13.3	92.86	99.61	31.8
72	11.0	7.7	12.9	73.40	100.02	--
73	16.6	3.4	5.4	39.57	48.89	--
74	16.1	3.0	4.4	30.91	39.27	--
75	16.8	2.9	4.6	32.72	42.19	--
76	18.0	3.1	7.3	37.00	75.06	--
77	18.9	3.1	8.0	38.91	84.20	--
78	13.4	2.9	8.3	28.32	75.60	--
79	14.7	4.1	12.0	41.45	122.75	--
80	16.3	3.8	11.3	43.74	173.99	--
81	11.1	5.6	11.6	46.19	96.39	--
82	10.5	6.9	12.3	58.64	99.91	--
83	10.4	4.6	14.0	30.25	126.43	--
84	12.0	4.4	11.7	36.13	111.13	29.4
85	16.8	4.1	5.7	51.97	48.11	
86	16.7	3.5	3.6	36.51	31.75	
87	15.8	2.9	4.2	31.11	38.24	--
88	17.8	3.9	8.6	49.01	87.92	--
89	16.7	3.7	9.3	46.44	87.87	--
90	16.8	3.3	7.1	39.92	71.49	
91	12.8	7.9	11.5	84.06	93.00	29.6
92	15.7	6.7	11.9	69.29	121.34	--
93	13.6	5.6	9.8	49.83	83.77	25.0
94	9.3	7.3	14.0	58.81	101.10	

.../continued

Table 4...continued

Weld I.D. No.	Bead Width (x) (mm)	Deposited Bead Height (Y_1) (mm)	Fused Bead Penetration (Y_2) (mm)	Deposited Area (A_1) (mm^2)	Fused Area (A_2) (mm^2)	Fused Boundary (L_2) (mm)
95	11.5	7.4	13.6	64.07	113.94	
96	13.4	7.3	13.2	77.64	122.44	
97						
98	10.1	7.2	1.5	68.67	7.3	
99						
100						
101						
102						
103						
104						
105	17.3	3.4	6.5	44.72	65.62	
106						
107						
108						
109						
110	16.3	4.6	2.8	53.39	24.00	
111	15.7	4.6	2.6	52.69	18.78	--
112	16.8	5.1	4.9	70.71	42.75	--
113						
114	17.5	4.7	4.2	64.30	36.86	--
115	11.8	7.6	9.3	78.85	77.73	--
116	14.1	6.3	8.8	73.46	74.14	--
117	15.8	5.0	8.6	64.27	78.25	--
118	10.9	10.1	12.1	101.97	85.66	--
119						
120	11.0	8.5	12.6	80.40	92.80	--
121	17.1	3.8	4.1	46.15	31.76	--
122	15.5	3.3	3.1	32.52	23.68	--
123	16.2	3.1	3.8	33.82	33.34	--
124	17.4	3.2	5.6	39.30	55.29	--
125	17.8	3.0	6.5	37.55	61.27	--
126	17.6	4.7	4.2	64.30	36.86	--
127	15.9	3.5	8.9	40.14	86.44	--
128	17.8	2.8	7.8	33.80	76.08	--
129	16.1	2.8	8.1	30.82	72.55	--
130	11.0	6.3	13.0	53.10	111.13	--
131	15.1	3.6	11.7	35.37	114.21	--
132	13.8	3.1	10.8	29.93	107.54	--
133	15.9	5.0	4.3	51.47	32.81	18.9
134	17.2	4.1	3.9	49.26	32.59	--
135	15.5	3.4	3.7	36.30	27.55	--
136	17.8	4.2	5.5	50.93	55.95	22.23
137	17.6	3.6	6.1	44.80	61.13	
138	16.9	3.6	5.6	41.38	52.85	--
139	10.7	7.4	11.9	68.00	85.40	--
140	15.8	5.3	10.9	60.33	99.12	--
141	15.0	5.2	10.1	57.43	87.07	26.8
142	11.3	9.3	13.9	95.51	98.33	--

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Table 4...continued

Weld I.D. No.	Bead Width (x) (mm)	Deposited Bead Height (Y_1) (mm)	Fused Bead Penetration (Y_2) (mm)	Deposited Area (A_1) (mm^2)	Fused Area (A_2) (mm^2)	Fused Boundary (L_2) (mm)
143	11.5	6.8	13.1	62.89	104.37	--
144	12.9	5.5	12.5	55.75	107.21	--
145	17.5	4.6	3.0	53.45	27.08	--
146	16.4	4.0	2.5	44.35	22.26	--
147	15.2	5.9	2.9	53.62	20.98	--
148	18.1	4.0	4.6	52.97	43.84	--
149	17.2	3.9	4.7	50.40	40.71	--
150	20.1	3.7	4.4	50.06	40.90	--
151	16.4	4.4	7.1	57.01	70.89	
152	17.6	4.2	6.5	55.56	64.18	--
153	18.1	3.2	5.2	40.80	51.87	--
154	11.7	4.9	12.0	44.95	98.91	--
155	13.3	6.0	11.8	61.63	99.73	--
156	17.2	3.4	9.6	41.76	105.86	--
157	16.3	5.2	3.1	59.79	24.18	--
158	15.5	4.7	3.0	53.00	24.91	
159	15.0	4.5	2.6	49.79	20.25	
160	15.5	4.9	4.9	64.00	40.38	
161	17.0	4.9	4.5	66.67	38.98	
162	16.9	4.2	3.7	53.45	31.80	
163	13.7	8.5	9.2	102.10	77.64	
164	15.0	6.1	10.2	74.27	88.44	
165	15.5	5.1	9.0	56.54	90.07	
166	10.4	11.0	12.3	102.36	80.65	
167	10.5	7.3	12.0	66.76	87.48	
168	12.7	7.1	10.9	68.42	92.97	
169	16.2	3.3	4.2	38.71	33.34	
170	16.2	3.3	4.0	35.92	29.53	
171	15.6	3.4	3.9	35.30	30.78	
172	18.1	2.9	5.7	35.40	55.33	
173	16.3	3.3	6.0	32.61	54.56	20.8
174	16.2	3.3	5.7	34.69	54.78	20.7
175	16.3	3.5	8.9	41.67	86.69	27.3
176	17.2	2.9	8.3	37.39	80.25	
177	15.5	3.0	10.0	33.86	88.40	
178	13.2	4.6	12.6	37.23	112.58	32.66
179	13.3	4.4	12.5	36.63	111.99	
180	13.5	5.0	12.0	45.60	104.86	
181	17.5	4.4	3.9	35.30	30.78	
182	15.8	3.7	4.4	40.37	36.86	
183	16.3	4.4	4.3	46.66	32.81	19.5
184	17.1	4.2	5.7	52.45	47.70	--
185	18.4	3.7	5.3	49.32	55.33	--
186	17.2	3.4	4.8	40.86	45.67	--
187	11.7	6.1	12.2	61.18	99.96	--
188	12.8	5.9	11.0	58.11	94.30	--
189	16.1	4.1	10.6	48.51	103.06	--
190	10.0	9.9	14.4	93.29	93.17	--

.../continued

Table 4...continued

Weld I.D. No.	Bead Width (x) (mm)	Deposited Bead Height (Y_1) (mm)	Fused Bead Penetration (Y_2) (mm)	Deposited Area (A_1) (mm^2)	Fused Area (A_2) (mm^2)	Fused Boundary (L_2) (mm)
191	11.6	7.6	12.7	73.20	99.77	--
192	13.8	5.8	11.8	59.58	104.70	--
193						
194						
195						
196						
197						
198						
199						
200						
201						
202						
203						
204						
205	13.2	7.0	3.0	77.80	17.22	
206	8.0	6.1	1.1	44.08	4.27	7.4
207	12.4	6.7	1.2	65.49	7.47	
208	15.4	6.1	4.4	73.89	35.70	
209	14.7	5.5	3.4	63.91	31.25	--
210	18.1	4.3	3.3	54.80	34.86	--
211	14.8	6.7	6.7	74.70	58.29	--
212	15.4	5.7	6.9	67.23	65.62	--
213	16.3	4.7	6.6	59.50	62.81	--
214	10.5	8.1	11.4	71.88	84.43	--
215	14.4	7.8	10.7	84.33	97.54	28.5
216	14.9	6.4	9.4	72.25	89.21	--
217	14.3	6.0	6.8	66.46	58.58	--
218	16.0	3.4	2.4	35.91	25.53	--
219	16.2	3.3	2.8	33.87	27.37	--
220	21.1	3.0	5.6	38.29	67.55	--
221	17.7	3.1	5.4	35.01	56.73	--
222						
223	15.9	2.7	9.8	30.61	94.12	--
224	17.3	2.9	9.8	32.97	96.13	--
225	17.4	2.8	8.8	32.08	88.39	26.1
226	14.5	4.8	11.8	46.01	109.14	31.1
227						
228	16.7	2.9	10.6	36.77	108.20	--
229	13.0	1.6	1.7	14.25	14.76	--
230	16.3	3.5	2.4	38.31	24.97	--
231	14.5	4.3	2.1	41.91	20.74	--
232	17.0	4.5	3.1	55.45	32.27	--
233	17.3	4.8	5.4	54.63	41.09	21.7
234						
235	14.6	5.6	9.5	60.72	87.32	--
236	15.4	4.2	9.4	51.00	87.97	--

.../continued

Table 4...continued

Weld I.D. No.	Bead Width (x) (mm)	Deposited Bead Height (Y_1) (mm)	Fused Bead Penetration (Y_2) (mm)	Deposited Area (A_1) (mm^2)	Fused Area (A_2) (mm^2)	Fused Boundary (L_2) (mm)
237	17.1	4.6	8.7	57.04	83.36	--
238	10.7	8.0	12.9	74.21	102.19	--
239	14.0	8.0	11.3	96.09	94.14	--
240	14.4	6.2	11.1	68.70	98.29	--
241	12.0	5.4	2.6	54.66	16.98	--
242	8.2	6.7	1.4	52.57	5.77	--
243	14.3	5.8	1.8	57.73	14.98	--
244	13.3	5.2	3.8	55.13	32.69	--
245	16.3	4.8	3.1	54.56	29.04	--
246	16.7	4.2	3.3	51.38	32.40	--
247						
248	15.7	4.5	6.4	52.85	61.14	--
249	17.6	3.8	6.3	49.00	62.24	--
250	12.8	6.4	10.3	59.74	85.47	--
251	15.4	4.8	9.2	54.61	90.35	--
252	16.7	4.3	8.5	51.64	90.19	--
253						
254	10.1	6.4	1.8	61.13	10.67	--
255	9.3	6.4	1.4	51.49	7.95	--
256	14.0	6.4	4.9	73.04	38.18	--
257	15.0	6.1	3.7	69.00	29.28	16.9
258	17.0	6.4	3.0	83.95	28.13	--
259	14.9	5.8	3.8	67.93	30.32	--
260	15.0	5.8	7.2	69.04	67.61	--
261	15.1	5.4	6.2	61.64	58.79	--
262	11.0	9.7	10.3	98.55	70.81	--
263	13.8	6.7	9.7	74.08	93.66	--
264						
265	15.2	3.2	2.3	33.65	23.49	--
266	18.4	3.3	2.3	38.63	27.18	--
267	16.4	3.1	2.2	29.96	24.62	--
268	19.1	3.0	5.4	37.22	57.99	--
269	19.4	3.1	4.9	38.65	53.12	22.5
270	19.3	2.9	4.8	34.49	57.60	--
271	16.8	3.5	9.0	41.61	87.47	--
272	17.1	3.1	9.7	36.33	96.91	--
273	18.4	2.8	7.1	34.32	69.93	--
274	14.2	5.7	12.1	56.26	113.10	--
275	17.1	4.0	11.8	45.41	120.38	--
276	15.5	3.7	11.9	39.63	104.12	--
277	17.9	3.5	2.7	39.89	29.10	--
278	17.0	3.5	1.9	40.27	20.73	--
279	16.8	3.4	2.2	38.55	23.15	--
280	20.1	4.0	4.4	54.99	48.20	--
281	19.6	3.7	4.7	50.29	52.06	--
282	19.4	3.4	5.8	45.21	66.30	--
283	15.4	5.9	9.8	67.21	99.92	28.4
284	18.0	4.4	9.4	57.94	96.75	--

.../continued

Table 4...continued

Weld I.D. No.	Bead Width (x) (mm)	Deposited Bead Height (Y_1) (mm)	Fused Bead Penetration (Y_2) (mm)	Deposited Area (A_1) (mm^2)	Fused Area (A_2) (mm^2)	Fused Boundary (L_2) (mm)
285	18.8	4.0	7.6	50.80	79.06	--
286	11.9	8.4	12.5	87.14	100.61	--
287	13.1	7.1	11.9	65.17	99.77	29.6
288	15.3	5.7	10.2	65.80	104.71	--
289	16.0	3.7	4.7	41.12	39.90	--
290	16.9	3.4	5.2	42.03	53.26	--
291	16.8	3.7	8.2	44.69	83.16	--
292	15.7	4.5	9.0	53.62	86.50	--
293	16.0	2.9	4.3	28.14	40.91	--
294	18.8	2.8	4.8	35.09	50.94	--
295	17.4	2.6	6.6	31.78	68.88	--
296	15.8	3.0	8.0	35.77	82.29	--
297	14.9	3.6	4.1	36.77	36.63	--
298	17.1	3.8	5.1	50.24	50.86	--
299	15.1	5.5	9.3	61.19	82.77	--
300	14.2	6.2	10.6	65.21	92.19	--
301	16.3	3.5	4.0	38.13	34.19	--
302	17.5	3.6	3.5	44.80	38.98	--
303	18.8	4.2	7.1	58.07	66.34	--
304	14.8	3.9	10.6	43.25	94.49	--
305	14.8	3.6	4.2	39.15	37.07	--
306	15.4	3.9	5.1	45.67	47.28	--
307	14.3	4.5	8.8	48.65	76.91	--
308	12.9	5.6	11.3	60.89	84.62	--
309	16.7	3.4	4.4	37.27	39.79	--
310	18.3	3.4	4.8	43.85	45.18	--
311	19.6	3.4	6.7	48.45	66.13	--
312	16.6	4.0	9.4	48.53	91.31	--
313	15.4	3.7	4.4	37.26	39.28	--
314	15.2	4.2	5.5	48.35	53.37	--
315	13.1	6.4	10.2	63.87	80.66	--
316	12.8	11.2	5.9	88.56	56.50	--
317	16.3	3.9	4.0	43.26	33.76	--
318	15.3	3.0	6.3	34.90	63.12	--
319	14.7	5.8	9.1	59.44	80.30	--
320	11.4	7.7	11.4	75.88	85.40	--
321	18.5	3.1	6.2	41.61	60.67	--
322	15.8	3.8	5.6	41.20	54.58	--
323	14.6	4.7	8.1	51.28	74.41	--
324	13.7	5.9	10.5	59.79	88.54	--
325	15.6	3.5	2.5	34.58	29.27	--
326	17.8	3.8	6.5	42.70	63.02	--
327	16.5	4.2	5.9	50.54	55.02	
328	15.8	4.4	10.0	49.92	91.10	--
329	14.9	4.7	3.1	48.45	29.75	--
330	16.5	4.9	4.6	58.90	41.56	--
331	13.1	6.7	7.8	63.06	68.66	--
332	11.6	9.4	12.1	87.66	84.63	--
333	17.1	4.0	2.6	45.84	30.75	--

.../continued

Table 4...continued

Weld I.D. No.	Bead Width (x) (mm)	Deposited Bead Height (Y_1) (mm)	Fused Bead Penetration (Y_2) (mm)	Deposited Area (A_1) (mm^2)	Fused Area (A_2) (mm^2)	Fused Boundary (L_2) (mm)
334	18.5	4.2	4.6	52.62	50.38	--
335	14.7	5.0	7.2	55.78	65.66	--
336	15.4	6.6	10.6	75.78	90.201	--
337	No weld made					
338	No weld made					
339	No weld made					
340	No weld made					
341	8.3	3.1	2.6	19.01	13.00	10.6
342	8.6	2.4	2.5	13.78	12.81	10.7
343	9.4	4.2	3.7	28.18	16.38	12.2
344	8.1	3.8	2.4	21.68	8.77	10.0
345	9.3	4.2	2.4	29.20	12.24	10.6
346	10.5	3.2	2.9	20.49	14.09	12.5
347	9.8	2.7	1.9	16.27	10.38	10.8
348						
349	9.1	3.9	2.9	25.47	14.66	11.3
350	8.1	3.6	2.4	20.12	9.72	9.7
351	8.6	4.3	3.1	27.26	12.99	11.5
352	8.8	5.3	2.9	34.37	11.53	11.4
353	9.6	2.6	1.6	16.59	6.25	10.7
354	9.4	2.9	2.5	18.19	10.78	11.5
355	9.2	3.3	1.9	22.62	12.54	10.5
356	7.7	3.4	1.9	19.21	8.70	9.4
357	8.4	4.3	2.6	24.97	11.22	10.2
358	8.6	4.9	2.9	33.13	13.43	10.9
359						
360	8.6	4.9	2.7	33.21	12.09	10.6
361	No weld made					
362						
363	No weld made					
364	No weld made					
365						
366	8.4	5.2	2.8	34.32	11.49	11.0
367						
368	8.7	5.3	16.3	36.14	59.43	25.95
369						
370						
371	9.5	3.6	1.6	24.38	8.51	10.8
372	9.9	4.7	2.2	35.34	14.01	11.9
373	No weld made					
374	7.9	5.3	1.6	35.14	6.93	8.7
375	7.0	1.5	1.6	5.15	5.50	7.8
376	No weld made					
377	9.7	4.2	1.2	28.67	7.03	10.6
378	9.1	3.7	1.7	24.03	10.89	19.2
379	9.6	4.3	2.6	27.86	15.51	11.3
380	10.6	4.2	1.2	31.13	7.25	11.3
381	10.8	5.1	1.7	34.95	7.06	11.6
382	9.9	5.6	2.3	41.15	8.34	11.3

.../continued

Table 4...continued

Weld I.D. No.	Bead Width (x) (mm)	Deposited Bead Height (Y_1) (mm)	Fused Bead Penetration (Y_2) (mm)	Deposited Area (A_1) (mm^2)	Fused Area (A_2) (mm^2)	Fused Boundary (L_2) (mm)
383	8.1	4.1	1.7	26.66	7.90	8.9
384	8.8	3.7	2.1	23.61	10.40	10.4
385	10.4	4.2	2.5	29.65	14.51	12.0
386	9.7	4.8	1.1	34.97	5.89	10.3
387	9.9	5.3	1.9	38.03	6.68	10.7
388	9.1	2.0	2.0	6.69	7.69	10.3
389	No weld made					
390	No weld made					
391	7.9	4.7	2.0	28.81	6.23	9.3
392	6.9	5.8	0.9	34.82	3.26	6.9
393	7.3	5.9	1.2	37.54	2.99	7.7
394	7.7	5.6	1.1	34.91	2.47	8.1
395	9.3	5.3	1.7	35.42	7.26	9.8
396	8.1	5.8	1.8	37.88	5.45	9.1
397	7.6	4.5	1.5	27.27	5.23	8.4
398	8.6	5.9	1.2	40.91	3.68	8.9
399	No section cut					
400	No section cut					
401	8.0	5.3	1.8	34.78	5.49	8.9
402	8.3	5.8	1.8	40.67	6.77	9.5
403	7.1	5.1	1.4	30.17	5.04	7.6
404	9.9	5.9	1.0	43.31	3.41	10.2
405						
406	No section cut					
407	7.2	5.6	1.0	34.74	2.08	7.4
408	8.3	5.7	1.4	39.27	3.31	9.0
409	6.5	5.2	1.2	28.68	3.42	6.7
410	6.9	6.2	0.7	39.40	2.16	6.3
411	No section cut					
412	No section cut					
413	16.6	2.9	3.9	30.46	34.90	19.2
414	18.0	4.4	7.5	50.36	47.26	26.2
415	13.9	6.2	10.7	70.30	61.13	27.9
416	13.4	4.0	5.2	35.28	29.29	18.3
417	11.7	6.1	6.6	56.19	32.17	19.0
418	9.5	8.4	7.8	71.22	35.68	19.3
419	14.4	3.2	3.0	28.25	20.97	16.3
420	14.9	3.5	6.6	33.65	34.23	22.5
421	10.4	5.8	10.3	45.33	47.80	24.5
422	11.7	3.4	4.5	24.75	21.66	15.4
423	9.6	4.9	6.4	33.37	28.15	17.0
424	9.1	6.5	7.0	51.40	27.94	18.0
425	15.8	4.7	4.5	53.48	27.56	19.1
426	13.7	7.0	6.6	79.34	36.35	20.3
427	14.0	7.7	7.1	87.76	37.73	21.2
428	11.8	5.8	4.2	56.14	21.32	15.3
429	13.7	7.5	4.2	85.10	19.20	17.3
430	14.3	7.5	4.3	84.38	20.90	17.4
431	12.2	3.9	4.1	33.37	23.11	15.6

.../continued

Table 4...continued

Weld I.D. No.	Bead Width (x) (mm)	Deposited Bead Height (Y_1) (mm)	Fused Bead Penetration (Y_2) (mm)	Deposited Area (A_1) (mm^2)	Fused Area (A_2) (mm^2)	Fused Boundary (L_2) (mm)
432	12.4	5.4	6.1	54.15	31.25	18.6
433	10.4	6.7	6.2	58.08	28.59	17.6
434	10.2	4.9	3.7	36.60	17.66	13.5
435	11.7	5.8	2.6	51.73	10.20	13.2
436	12.1	5.7	3.2	51.45	13.94	15.0
437	16.5	6.1	2.1	76.84	13.21	17.8
438	17.6	6.3	3.4	90.10	18.46	19.7
439	No weld made					
440	16.1	6.9	1.2	92.26	4.36	14.9
441						
442	No weld made					
443	12.2	5.1	2.5	42.34	13.71	13.6
444	13.8	5.7	3.0	56.57	13.59	16.5
445	No weld made					
446	11.1	5.9	2.3	48.98	9.06	12.6
447	13.9	5.7	.52	60.16	.97	14.2
448	No weld made					
449	15.7	4.7	2.2	48.98	18.49	16.8
450	17.2	4.7	2.7	58.43	21.78	18.6
451	19.0	5.3	7.0	74.61	41.34	26.9
452	15.7	5.1	2.9	50.93	15.72	17.4
453	15.2	5.7	4.3	66.73	23.89	18.5
454	14.3	7.2	5.8	84.48	33.98	19.3
455	12.3	3.9	2.8	30.96	15.66	14.2
456	15.4	4.3	3.3	41.85	23.54	17.4
457	13.8	5.2	5.8	51.85	31.53	
458	12.9	4.4	2.7	33.17	13.94	14.5
459	13.3	4.9	3.6	41.01	16.94	15.8
460	11.5	6.3	4.2	56.61	21.14	14.5
461	14.2	4.2	4.1	42.48	28.39	17.2
462	13.8	5.1	5.2	52.60	28.21	17.9
463	14.3	6.8	6.2	76.74	30.63	20.4
464	11.4	4.7	2.9	40.82	16.02	13.3
465	11.3	5.6	3.4	51.44	15.23	13.4
466	13.6	5.5	2.7	54.91	10.25	14.8
467	11.7	3.2	3.4	24.13	15.53	14.4
468	13.7	3.9	4.7	38.14	27.14	18.0
469	10.8	6.1	7.6	49.60	31.56	20.3
470						
471	8.6	4.7	3.3	33.33	12.83	11.2
472	11.7	4.4	1.7	38.37	5.13	12.6
473	12.7	6.2	3.6	63.97	17.45	14.9
474	13.5	6.4	2.1	76.25	8.42	14.2
475	15.5	7.0	2.1	85.60	9.63	16.7
476	11.0	6.3	2.2	58.94	9.35	12.1
477	12.5	6.2	.60	63.57	1.60	12.3
478	16.1	6.3	0.7	76.03	1.88	16.6
479	10.7	4.9	2.6	37.28	12.35	12.2
480	14.0	5.5	2.7	52.30	12.08	15.6

.../continued

Table 4...continued

Weld I.D. No.	Bead Width (x) (mm)	Deposited Bead Height (Y_1) (mm)	Fused Bead Penetration (Y_2) (mm)	Deposited Area (A_1) (mm^2)	Fused Area (A_2) (mm^2)	Fused Boundary (L_2) (mm)
481	13.9	5.6	2.3	55.05	11.07	15.5
482	8.9	5.7	2.2	41.46	9.06	10.3
493	13.9	5.7	1.2	56.73	4.67	14.6
484	14.2	6.1	0.5	59.31	0.47	14.6
485	12.2	6.2	1.5	62.35	6.83	12.6
486	13.5	7.3	1.8	84.46	5.99	13.0
487	15.7	6.4	1.8	82.63	10.82	16.2
488	14.4	6.3	1.8	68.75	6.93	15.0
489	13.7	6.8	1.6	79.81	6.20	14.3
490	15.7	6.9	1.6	91.96	5.98	16.4
491	11.1	5.3	2.3	44.80	10.43	12.8
492	12.0	6.1	2.4	55.51	12.41	13.4
493	11.5	6.1	2.7	55.50	13.37	13.0
494	8.5	6.1	1.0	44.07	2.58	8.2
495	12.0	5.7	0.6	46.81	.91	12.4
496	11.8	5.7	0.9	52.71	2.55	12.6
497	12.9	5.7	2.8	52.25	13.20	14.9
498	13.4	5.8	3.5	56.33	20.77	16.0
499	15.7	6.1	4.1	70.61	27.46	18.5
500	11.9	5.6	1.9	50.73	7.12	12.8
501	16.5	5.8	2.4	67.86	11.48	18.0
502	16.5	6.6	3.0	82.07	14.98	18.4
503	9.0	4.9	2.5	34.97	10.02	11.0
504	11.8	5.1	3.0	44.82	15.60	13.7
505	13.6	5.8	4.2	54.45	24.04	17.1
506	10.0	4.9	1.8	33.38	6.25	11.0
507	13.2	5.4	1.8	44.34	10.10	14.1
508	12.5	5.8	3.0	53.64	14.11	14.5
509	15.6	3.0	3.3	34.19	35.12	18.1
510	22.9	2.8	4.1	39.65	53.31	26.8
511	22.9	3.6	8.1	53.10	76.53	29.8
512	16.0	3.1	4.3	28.91	35.22	18.6
513	16.8	4.2	5.6	42.87	46.23	21.6
514	17.5	5.1	8.7	55.77	66.29	26.8
515	12.1	2.2	3.5	19.22	28.50	15.2
516	13.4	3.0	4.1	25.22	36.89	16.9
517	14.7	4.3	5.0	40.74	43.75	18.7
518	12.9	2.9	4.2	22.40	30.94	16.3
519	11.9	3.5	5.6	29.55	38.01	17.4
520	12.1	4.6	7.7	38.19	59.11	21.5
521	20.4	3.0	3.9	40.21	44.15	23.6
522	19.1	4.0	5.8	52.80	54.45	24.0
523	17.9	6.3	9.4	81.45	74.41	28.2
524	15.3	4.5	5.4	43.71	37.80	19.8
525	17.1	5.8	6.7	71.85	17.75	33.3
526	14.7	7.5	7.8	88.74	51.89	25.3
527	17.7	2.6	3.5	28.47	36.46	19.6
528	12.9	3.8	4.8	32.78	35.84	17.1
529	15.1	5.1	5.8	49.99	35.15	20.9

.../continued

Table 4...continued

Weld I.D. No.	Bead Width (x) (mm)	Deposited Bead Height (Y_1) (mm)	Fused Bead Penetration (Y_2) (mm)	Deposited Area (A_1) (mm^2)	Fused Area (A_2) (mm^2)	Fused Boundary (L_2) (mm)
530	12.4	3.4	4.6	25.06	28.93	16.5
531	12.2	4.9	6.6	41.79	34.80	19.9
532	10.9	6.7	8.8	58.00	43.63	22.8
533	16.8	4.9	3.5	57.42	31.30	18.8
534	18.2	5.6	3.9	69.87	39.21	20.5
535	21.2	6.2	5.9	93.80	47.59	26.4
536	17.6	4.5	3.5	53.25	24.41	20.1
537	20.4	3.8	3.8	24.52	25.23	23.2
538						
539	14.2	4.6	2.6	42.64		
540	14.9	5.0	3.4	50.43	28.55	16.8
541	15.3	5.7	5.6	62.78	41.71	20.3
542	11.7	4.6	2.3	37.45	14.98	13.0
543	15.4	5.4	4.0	50.79	24.19	18.7
544	13.3	5.8	4.7	59.09	31.68	17.8
545	19.3	3.9	3.0	47.75	33.77	21.3
546	19.3	4.3	4.2	57.21	38.86	21.7
547	19.2	5.3	5.6	68.44	58.77	23.5
548	17.9	4.4	3.2	41.46	29.77	19.8
549	18.4	4.8	4.7	54.64	38.63	21.8
550						
551	14.9	3.6	2.2	33.74	21.00	16.7
552	14.4	4.1	3.2	40.03	26.88	16.5
553	14.4	4.9	3.9	48.67	36.83	17.2
554	13.8	3.6	3.3	28.43	23.56	15.7
555	14.3	4.1	4.3	39.68	20.94	21.7
556	14.1	4.7	4.8	45.82	32.04	18.0
557	No weld made					
558	No weld made					
559	No weld made					
560	14.8	2.2	2.0	15.20	14.73	15.6
561	14.6	4.6	4.5	40.41	40.71	18.2
562	17.7	4.0	7.3	47.55	50.88	25.1
563	No weld made					
564	No weld made					
565	No weld made					
566	12.1	2.7	1.6	20.75	13.72	14.0
567	13.1	2.9	4.5	24.92	32.42	16.7
568	13.1	3.5	6.5	30.34	37.39	19.8
589	13.8	3.7	2.7	35.48	21.54	16.1
570	17.8	3.3	3.9	42.58	47.06	20.3
571	17.2	4.9	6.7	55.67	47.48	23.5
572	12.8	4.5	4.0	43.04	26.86	15.8
573	18.9	4.4	5.8	59.34	40.58	24.4
574	19.1	5.9	7.6	81.71	56.57	27.0
575	12.9	3.2	3.1	28.23	12.70	16.9
576	13.2	2.7	4.5	26.57	27.59	17.3
577	15.3	4.5	5.4	46.97	31.56	20.0
578	12.2	3.2	4.1	27.72	29.25	16.1

.../continued

Table 4...continued

Weld I.D. No.	Bead Width (x) (mm)	Deposited Bead Height (Y_1) (mm)	Fused Bead Penetration (Y_2) (mm)	Deposited Area (A_1) (mm^2)	Fused Area (A_2) (mm^2)	Fused Boundary (L_2) (mm)
579	11.7	4.8	4.5	41.32	32.63	15.5
580	11.9	5.2	8.0	46.39	48.57	21.6
581	14.1	6.3	2.0	72.87	8.00	14.8
582	15.9	6.5	3.0	80.65	16.24	17.5
583	17.8	6.9	3.3	93.14	23.46	19.8
584	14.4	6.2	2.1	75.32	9.35	15.5
585	21.0	5.8	2.1	86.31	13.91	21.7
586	24.2	6.2	2.8	111.96	18.31	25.7
587	9.8	5.2	1.9	37.78	8.79	11.0
588	12.0	5.1	2.5	49.09	13.97	13.4
589	14.6	5.5	3.2	58.71	20.96	16.6
590	11.0	1.7	1.7	9.66	8.78	11.9
591	13.7	5.3	2.1	51.66	11.85	14.3
592	16.3	5.7	2.7	65.53	17.90	17.9
593	No weld made					
594	No weld made					
595	No weld made					
596	13.2	5.7	2.4	62.03	10.62	14.7
597	14.7	6.0	2.8	68.92	18.51	16.0
598	17.3	5.7	2.9	73.56	28.54	18.8
599	No weld made					
600	No weld made					
601	No weld made					
602	10.7	5.2	15.4	40.85	69.37	27.6
603	12.4	5.4	2.7	50.44	17.29	14.1
604	13.0	5.4	2.8	50.33	17.87	14.8